Chapter 5
Preparation of Plans and Specifications

5-1. Selection of Guide Specification for Concrete

a. General. The use of guide specifications is prescribed by ER 1110-2-1200, "Plans and Specifications." Guide specifications for concrete are used to ensure that the requirements for concrete construction for all projects will be consistent and that the concrete produced will be uniform in properties, of required quality, and economical. There are several guide specifications available for concrete placed on Corps of Engineers civil works projects. These guide specifications should be used in every case, with the only exceptions being for situations requiring the use of special concrete applications not covered in guide specifications. Changes should be limited to minor technical changes unless approved in the DM. No changes should be made in the format. The completion of project specifications will be based on the approved concrete materials DM.

b. Guidelines for selection. If the project for which specifications are being prepared involves mostly mass concrete as in a lock or dam, Guide Specification CW-03305, "Mass Concrete," should be used. For an important structure, other than a lock or dam, such as a powerhouse superstructure, bridge, fish hatchery complex, visitor center, tunnel lining, major pumping station, intake structure, or other structures appurtenant to embankment dams where reinforced concrete is required, the Guide Specification CW-03301, "Cast-in-Place Structural Concrete," should be used. If the project is a recreational site, road relocation, or other project involving small amounts of concrete in structures such as culvert headwalls, comfort stations, residences, or low headgate structures, the Guide Specification CW-03307, "Concrete (for Minor Structures)," should be used. There may be instances where more than one guide specification will be necessary on the same project. When this is the case, it will be important to precisely outline in the specification and on the plans which specification applies. The Guide Specification CW-03362, "Preplaced Aggregate Concrete," is chiefly applicable for repairs to damaged or deteriorated concrete structures.

c. Use of state specifications. The specifications of a state agency, such as a highway department, may be substituted for all or parts of the Guide Specification CW-03307, "Concrete (for Minor Structures)," when the work being accomplished will ultimately be operated or maintained or both by the state in which it is located or when savings will result due to the familiarity of local contractors with the more usual specifications. One area where savings may result would be in the substitution of state requirements for aggregate quality and grading when it is known that this is the material produced in greatest quantity by local aggregate producers.

d. Use of abbreviated specifications. For very small concrete placements, it may be justifiable to use an abbreviated specification of one or two pages in length produced by editing a state specification or the Guide Specification CW-03307, "Concrete (for Minor Structures)." Such abbreviated specifications should be considered when the only concrete on the project is being placed in picnic table bases, light bases, small culvert headwalls, or other small noncritical structures.

5-2. Guide Specification "Concrete (for Minor Structures)," CW-03307

a. General. This guide specification provides requirements for concrete of adequate quality for minor structures. All concrete must be air-entrained.

b. Cementitious materials options. The intent of the Guide Specification CW-03307, "Concrete for Minor Structures," is to allow the Contractor maximum flexibility to use locally available cementitious materials. Accordingly, the optional use of blended hydraulic cement would be allowed if such material is reliably available in the project area. Low-alkali portland cement would be a specified option if locally available aggregates are known or suspected to be potentially deleteriously alkali reactive. Increased resistance to sulfate attack may be obtained with blended hydraulic cement by specifying a suffix of MS following the type of designation. All specifications must allow the use of pozzolan; reference paragraph 2-2 of this manual.

c. Selection of compressive strength. The required specified compressive strength will be determined by the structural designer. Normally, a specified compressive strength (f'_c) of 3,000 psi at 28 days is a reasonable and attainable value in rural areas and remote locations where many of the minor structures are located. Higher values may be specified if required. The value specified should be confirmed as adequate by the designer in every case. If durability is a limiting design factor, the maximum w/c shall normally be limited to 0.50. Lower values may be specified if required. See Table 4-1.

d. Selection of nominal maximum aggregate size. The largest nominal maximum size aggregate incorporated into the minor structures intended to be covered by this specification is 37.5 mm (1-1/2 in.). If thin sections are involved or there is interference from reinforcement,

19.0-mm (3/4-in.) nominal maximum size aggregate will be specified. Generally, for sections 7-1/2 in. or less in width, heavily reinforced floor and roof slabs, and all sections where space is limited and surface appearance is important, 19.0-mm (3/4-in.) maximum size aggregate will be specified. For sections over 7-1/2 in. wide and in which the clear distance between reinforcement bars is at least 2-1/4 in., the maximum size aggregate specified shall be 37.5 mm (1-1/2 in.).

e. Finish requirements. This guide specification requires a floated finish on unformed surfaces with an optional paragraph for a steel-trowel finish. A float surface will be adequate for most of the concrete covered by this specification; however, for shop or office floors, other areas where frequent cleaning is necessary, and areas to be painted or covered by other floor coverings, a steel-trowel finish should be specified.

5-3. Guide Specification "Cast-in-Place Structural Concrete," CW-03301

a. General. The Guide Specification CW-03301, "Cast-in-Place Structural Concrete," is for use on important reinforced structures; therefore, it is not intended to be edited except to select available options. Guidance for the selection of the options is provided in the following paragraphs. Any substantial departures from the guide specifications must be included in the appropriate DM for approval.

b. Testing of cementitious materials. Essentially, there are two options provided in the guide specification to define the required preconstruction testing or certification of cement and pozzolan. The procedures to be followed when cements and pozzolan are to be sampled and tested by the Government prior to their use in the construction to determine compliance or noncompliance with the specifications are specified. The Contractor may also elect to use cement or pozzolan from a source which has been prequalified by the Government. These guide specifications define those conditions that must be met for the acceptance of cementitious materials on the basis of a manufacturer's certification of compliance accompanied by mill test reports. The decision to use the more restrictive paragraphs should be based on the criticality of the structure involved. Generally, government testing will be used for powerhouse structures and any structures appurtenant to locks and dams that control water, to include tunnel lining, large gate structures, intake structures, stilling basins, and major bridges. Certification accompanied by mill test reports, will suffice for fish hatchery structures, maintenance structures, and others not specifically designed for the control of water downstream. If cementitious materials are to be tested by the Government, the U.S. Army Engineer Waterways Experiment Station (ATTN: CEWES-SC) should be contacted for a current cost. Cement or pozzolan sources that are prequalified must also be periodically tested during construction at CEWES-SC, and the tests must be funded.

c. Admixtures and curing compounds. Optional paragraphs of CW-03301 provide for air-entraining admixtures, water-reducing admixtures, and curing compounds to be accepted on the basis of either preconstruction testing by the Government or certifications of compliance submitted by the Contractor. The decision as to which option to use for the admixtures or curing compounds should be based on the criticality of the structures involved and on past experience with the products and suppliers in the project area. If problems have occurred on other projects, then the product should be tested by the Government to assure compliance.

d. Testing of aggregate. The division laboratory which will receive the samples should be contacted and the sample sizes and the number of days required to evaluate the aggregates established. The number of days listed for the testing of the aggregate should be chosen to be long enough to provide for unforeseen delays at the laboratory so that the Contractor claims which would result if the evaluation were delayed can be avoided.

e. Nonshrink grout. The type(s) of nonshrink grout to be used are to be selected by the Contractor in accordance with ASTM C 1107 (CRD-C 21). The decision as to the type of nonshrink grout should be based on the application, exposure conditions, and the manufacturer's recommendations. If severe exposure conditions are anticipated, testing should be performed on the types of nonshrink grouts specified to assure their adequacy. If the Contractor selects a Grade A prehardening volume adjusting grout, the space to be grouted must be confined on all sides.

f. Cementing materials option. The inclusion or exclusion of available cementing materials options in the preparation of project specifications must be based on and supported by the results of the investigations outlined in Chapter 2 of this document. The guide specifications provide, as options, those types of portland cement and blended hydraulic cements generally used for cast-in place structural concrete, and the Contractor should be allowed the widest choice possible subject to specific suitability and availability. The Contractor must be allowed the option of using fly ash.

g. Specifying aggregate. The coarse aggregate gradings and aggregate quality to be specified in the guide specifications must be based on and supported by the investigations outlined in Chapter 2 of this document. The ASTM C-33 (CRD-C 133) sizes selected as options will depend on the nominal maximum size aggregate available and appropriate for use in the various project structures as specified in the guide specifications. The selection of the nominal maximum size coarse aggregate will also be based on the aggregate investigation. If technically feasible, the size number selected will correspond to those available in whatever commercial aggregate sources are listed. Note that size No. 1, 2, 3, and 357 will not be specified since the nominal maximum size represented by these designations exceeds 37.5 mm (1-1/2 in.), and size No. 7 and 8 are for "pea gravel" sizes not normally used in structural concrete.

h. Strength. The paragraph in part one of CW-03301 entitled "Design Requirements" lists the strengths required for the various portions of the structure. It is necessary for the designer to determine what strength is required and the age at which the strength is needed or the design age. Typically, this is 28 days; however, if construction or operational loads are not anticipated for some longer period of time, economies can be realized in the concrete by proportioning concrete mixtures to attain design strengths at later ages such as 90 or 180 days. It should be noted, however, that durability requirements might result in higher strengths due to the w/c requirements.

i. Batch-plant capacity. The computation of batch-plant capacity for cast-in-place structural concrete will be based on an assessment of the likely placement sequence on the project. See Chapter 3 of this manual for guidance in selecting the batch-plant capacity.

j. Batch-plant controls. The batch-plant control system specified for cast-in-place structural concrete may be partially automatic, semiautomatic, or automatic. The semiautomatic plant should be provided with interlocks and recorders if the project includes major structures. If technically feasible, the batch-plant requirements should coincide with the equipment which is locally available. See Chapter 3 of this manual for more guidance on selection of batch-plant type.

k. Concrete deposited in water. The optional paragraph, CW-03301, entitled "Placing Concrete Under-water" will be included in all specifications for projects which include underwater placement of concrete. The decision to use underwater placement in lieu of dewatering must be discussed in the Concrete Materials DM.

l. Finishing unformed surfaces. Subparagraphs are provided in paragraph 8-3 entitled "Finishing" to provide an abrasive aggregate finish, a broom finish, or a bonded two-course floor. The abrasive aggregate finish or broom finish should be applied in those areas where slippery floor surfaces would present a problem. A bonded two-course floor would be an option for a warehouse area or other surface exposed to heavy loads, traffic, and abrasion.

m. Sheet curing. Sheet curing may be specified for horizontally finished surfaces such as roof slabs, floors not subject to public view, or floors that are to be covered with tile or resilient flooring by listing the areas to be so cured. Polyethylene film shall not be used unless it is coated with burlap or other materials.

n. Areas to be painted. If the project includes large areas of concrete surfaces to be painted, they should be impervious sheet cured, moist cured, or cured with a chlorinated rubber base curing compound specified by reference to ASTM C 309, (CRD-C 304) Class B.

o. Finishing formed surfaces. Optional subparagraphs are included in the paragraph entitled "Formed Surfaces" to provide for various finishes to achieve desired architectural effects. The selection of the optional paragraphs will depend on architectural requirements. The architectural drawings should be consulted when preparing this paragraph. When extensive use of architectural finishes are planned, guidance for expanded specifications may be obtained from CECW-EG. ACI 303R is an excellent reference.

p. Floor tolerance. The optional paragraph in part 3, CW-03301, entitled "Slab Tolerance by F-number System" may be used as this technology becomes available in the local project area or immediately as a very flat floor is necessary. Reference the discussion in Chapter 8 of this manual before specifying the F-number system.

5-4. Guide Specification "Mass Concrete," CW-03305

a. General. This specification is intended for large civil works structures of predominately mass concrete. These structures are almost always important water control structures. This guide specification is the most restrictive of the guides for concrete construction and is intended to be used unedited except for selecting available options, unless a deviation has been approved in advance in the materials DM. Guidance for the selections of some of the options is provided in the following paragraphs.

b. Sampling of aggregates. To complete the paragraph in part 2, CW-03305, entitled "Aggregates," CRD-C 100 and the concrete materials DM should be consulted. The division laboratory that will receive the samples should be contacted, and the sample sizes and the number of days required to evaluate the aggregate confirmed and established. The number of days listed for the testing of the aggregate should be chosen to be long enough to provide for unforeseen delays at the laboratory so that the contractor claims which could result if evaluation were delayed can be avoided. It may be necessary to have some overlap in the time required for aggregate quality testing and the time required for mixture proportioning studies so as to not delay the start of construction. Close coordination between the project office and the division laboratory is important.

c. Mixture proportioning studies. Mixture proportioning studies will be completed at the assigned Corps of Engineers division laboratory. It is necessary to insert the address of the assigned division laboratory in Guide Specification CW-03305. The quantities required for the mixture proportioning studies will be furnished by the laboratory. Materials shipped to the laboratory should be accompanied by the required contractor's quality and grading test reports. Government quality tests should be performed in the division laboratory as judged necessary, prior to mixture proportioning studies.

d. Testing cementitious materials. Current costs for testing hydraulic cement, pozzolan, and GGBF slag should be obtained from the Waterways Experiment Station (ATTN: CEWES-SC). The cost for testing of cementitious materials will be included in Guide Specification CW-03305. Samples and funding of testing is required even though prequalified sources are selected.

e. Surface requirements. Several classes of finish are available in CW-03305 to be employed as described in the following paragraphs.

(1) Class A finish. Class A finish is specified for surfaces of structures where excellent appearance at close range is important. Examples of Class A finish include exterior walls of buildings of all types such as superstructures of powerhouses and pumping plants, interior surfaces of such walls when no other finish treatment is to be added, floodwalls, and parapets, and other ornamental structures on dams. The required form materials for Class A finish are limited to new, well-matched tongue-and-groove lumber or new plywood panels as specified in the paragraph entitled "Materials" in Part 2 of CW-03101. The forms should be clean, tightly set, and securely anchored to prevent grout leaks.

(2) Class AHV finish. Class AHV is for finishes exposed to a high-velocity (greater than 40 fps) flow of water. Examples of this type of surface include lock filling and emptying ports, lock culverts, outlet works, and spillway tunnels. The forms should be strong and held rigidly and accurately to the specified alignment. The materials for forms are the same as Class A finish except that steel forms may be used.

(3) Class B finish. This finish is specified for permanently exposed surfaces where excellence of appearance treatment is not as paramount. Examples include concrete dams and appurtenances (except where Class A finish is required), retaining walls, floodwalls, exposed surfacing of culverts, and outlet works.

(4) Class C finish. This finish is specified for areas that are not normally exposed to public view but will not be permanently covered with backfill. Examples include machinery rooms and interior passageways in large projects.

(5) Class D finish. This finish is specified for concrete surfaces where roughness and irregularities are not objectionable. Examples include bulkhead faces of monoliths in mass concrete structures and surfaces against which backfill will be placed. The chief requirement of the form is that it be watertight.

(6) Absorptive form lining. Absorptive form lining *should not be specified.* Numerous problems have resulted due to the use of absorptive form linings: small air bubbles remaining immediately below a thin surface skin of mortar, form lining sticking to concrete surfaces, and in general, the results have not justified the extra cost.

f. Appearance. The paragraph in part 3 entitled "Curing and Protection" of CW-03305, "Guide Specification for Mass Concrete," provides for those surfaces on which discoloration would be aesthetically undesirable and therefore need to be removed. The surfaces are those permanently exposed to view by the general public. In areas where the only available curing water is likely to stain or where aggregate impurities contribute to staining, it may be economically infeasible to prevent or remove all staining, and staining should be removed only on those surfaces constantly exposed to public view on which staining would be aesthetically troublesome.

g. Cementitious materials option. The inclusion or exclusion of available cementing materials options in the preparation of project specifications must be based on and supported by the results of the investigation outlined in Chapter 2 of this manual. The guide specification provides

for those types of portland cement and blended hydraulic cements generally used for mass concrete and available in the project area. Consult the materials DM for those cementitious material options which should be allowed. The use of fly ash will be permitted.

h. Bid schedule for cementitious materials options. Provisions should be made in the bid form for optional bidding on all the available and acceptable cementitious materials. The estimated quantities of portland cement, blended hydraulic cement, and GGBF slag should be expressed in units of mass. The quantities may vary between the various cements due to differences in required mixture proportions and density. The estimated quantities of pozzolans should be expressed in units of solid volume (cubic feet). This allows for variations in density dependent on the source selected by the Contractor. The estimated quantities of both cement and pozzolan should be derived from information gained in the preparation of preliminary mixture proportions during the preparation of the concrete materials DM.

i. Retarder. The Contractor may use a retarder at his option except in areas where retardation is considered to be detrimental. A retarder is appropriate when uncooled concrete is to be placed in very hot weather and the placing schedule is such that a danger of cold joints exists or problems in finishing may be anticipated. Retarders are also applicable to special structures in which revibration will be used to ensure low permeability.

j. Water reducers. The mandatory use of WRA's should be restricted to locations where there is an economic advantage to the Government. A Contractor's request to use a WRA in structural concrete should be approved unless its use is harmful in a given situation. The material should meet the requirements of ASTM C 494, (CRD-C 87) Type A or D, unless retardation would be detrimental to the work, in which case only Type A should be specified. Since the economic benefits resulting from the use of an admixture usually cannot be evaluated until the Contractor has made his choice of materials, the bidding schedule should include a split bid for a WRA. The first item includes for mobilization and demobilization costs of storing, dispensing, and recording the admixture. When the laboratory evaluation indicates no economic benefit from use of the admixture, it is not necessary to approve its use.

k. Fine aggregate grading requirements. Fine aggregate grading is a major factor affecting the unit water requirement, fine aggregate-coarse aggregate ratio, and cement content of a concrete mixture. That portion of the fine aggregate finer than the 150-µm (No. 100) sieve has the most pronounced effect on these factors. While it is possible to proportion a workable normal strength concrete mixture using most naturally occurring sand deposits, those gradings that fall within the limits listed in the guide specifications are more practical, generally requiring less cement and water for adequate workability. Beneficiation of the natural deposits can be accomplished by use of equipment which will reject a specific size portion or which will blend in a finer sand will usually be cost effective. Most natural river sands are deficient in the sizes finer than the 150-µm (No. 100) sieve. This fine sand is often available and used in local asphaltic concrete paving mixes. The finess modulus (FM) is most useful in controlling the consistency of the fine aggregate during construction. The proposed fine aggregate grading requirement should be presented in the concrete materials DM. When manufactured sand is allowed in the project specifications, the optional requirement limiting the amount of material passing the 75-µm (No. 200) sieve should be used if the Contractor chooses to use manufactured sand. See paragraph 2-3b(8) of this manual entitled "Fine Aggregate Grading Requirements."

l. Coarse aggregate grading requirements. Whenever the maximum aggregate size is less than 150 mm (6 in.), the inapplicable portion of the table on coarse aggregate gradings should be deleted in the project specifications. When coarse aggregate is to be supplied from commercial sources in an area where local practice provides size group separations other than those in the table, the table may be appropriately modified providing the local grading practice permits adequate control of grading. The revised grading should be presented for approval in the concrete materials DM. Rescreening and washing will be required for all mass-concrete structures.

m. Batching and mixing plant.

(1) Type of plant. The specifications provide for two alternates, an automatic batching plant or a semiautomatic batching plant. The selection of batch-plant type will be based on and supported by the concrete materials DM. The paragraph entitled "Equipment" provides the option of an onsite or offsite plant. The selected option will also be based on the concrete materials design memorandum. (Reference Chapter 3 herein.)

(2) Capacity. The paragraph in part 2 entitled "Capacity" of CW-03305, "Guide Specification for Mass Concrete," requires that a minimum capacity for batching, mixing, and placing system be inserted. The determination of the plant capacity is a part of the preparation of the concrete materials DM, and the capacity inserted in the

specification should be supported by the DM. Chapter 3 of this manual gives additional guidance.

(3) Preset mixtures. If an automatic batching system is required, it is necessary to indicate the number of present mixtures that may be produced by the plant. This number should be based on the anticipated construction sequence and the number of different mixtures to be used in the various features of the projects at approximately the same time. For example, on a large dam it is likely that exterior and interior mass concrete will be placed at the same time but in different locations. It is also possible that structural concrete may be required during the same shift as mass concrete is being placed elsewhere. The number selected should be realistic, not excessive simply to avoid the needed planning and analysis.

(4) Mixers. Any type of stationary mixer may be used for mixing concrete containing 75- or 150-mm (3- or 6-in.) nominal maximum size aggregate if it meets the capacity and the uniformity requirements. Concrete containing 50-mm (2-in.) and smaller maximum size aggregate may be mixed in stationary or truck mixers.

n. Conveying and placing.

(1) Conveyance methods. Optional paragraphs are provided to cover belt conveyors and pump placement, and these should be included in the project specifications, or not, depending on the project. The concrete materials DM should be referred to when preparing the specifications paragraphs related to methods of conveyance.

(2) Hot-weather mixing and placing. To reduce the problems of slump loss and plastic shrinkage cracking, limits are placed on the temperature of the concrete when placed. For guidance in selecting the correct placing temperatures, see Table 8-1 of this manual.

(3) Placing temperature. An optional paragraph of CW-03305 requires a special placing temperature in certain portions of the structure. The selection of an alternate and the completion of the blanks within the paragraph chosen shall be based on and supported by the concrete materials DM or a separate DM on Thermal Studies as outlined in Chapter 3 of this manual.

(4) Lift thickness. Lift thicknesses are to be shown on the drawing which shall show the required and optional construction joints. The maximum lift height for each portion of the structure will be determined by the thermal study and documented in the appropriate DM.

(5) Placing concrete in unformed curved sections. This optional paragraph will be included in all specifications for projects that include an ogee spillway crest and spillway bucket.

(6) Concrete deposited in water. This optional paragraph will be included in all specifications for projects that include underwater placement concrete. The decision to use underwater placement in lieu of conventional dewatering must be discussed in the concrete materials design memorandum as outlined in Chapter 2 of this document.

o. Finishing.

(1) Unformed surfaces. A steel-trowel finish may be specified for those areas requiring it by listing the areas in the paragraph entitled "Trowel Finish" of the guide specifications. Steel-trowel finishes are generally required in areas where cleaning is required such as generator decks, visitor facilities, and shop and office areas. If the floors are to be overlaid with tile, coatings, or coverings, the manufacturer’s recommendations should be consulted when preparing the specifications to determine the finish requirements.

(2) Formed surfaces. The guide specification provides for four classes of finish for formed surfaces. The required class of finish must be denoted on the project plans. An AHV (Class A, high velocity) finish will be required on all surfaces exposed to water velocities of 40 ft/s or higher.

(3) Insulation and special protection. These paragraphs of CW-03305 contain blanks for cold-weather protection. The information inserted in these paragraphs will be based on and supported by the thermal study. It is also necessary to determine the age beyond which insulation will no longer be required. In areas where concrete placement is subject to a winter shutdown, it should be assumed that all mass concrete placed since the spring startup will be insulated throughout the following winter shutdown period unless results of the thermal study indicate otherwise.

p. Areas to be painted. If the project includes large areas of concrete surfaces that will be painted, they should be impervious-sheet cured, moist cured, or cured with a chlorinated-rubber base curing compound.

q. Setting of base plates and bearing plates. The paragraph with this title in CW-03305 with subparagraphs should be included in the project specifications if the project includes base plates or bearing plates. A gas-liberating

admixture should be used only when the area is essentially confined.

r. Measurement and payment. The paragraph entitled "Measurement and Payment," CW-03305, will be edited to reflect the outcome of the cementitious materials investigation outlined in Chapter 2 of this EM and documented in the concrete materials DM.

5-5. Guide Specification "Formwork for Concrete," CW-03101

a. General. The Guide Specification CW-03101, "Formwork for Concrete," will normally be included in any specification for a project which includes concrete in any amount. It is included as "related work specified elsewhere" in each of the three guide specifications for conventionally placed concrete, CW-03307, CW-03301, and CW-03305. Guidance for preparation of the project specifications is included in the following paragraphs.

b. Shop drawings. The number of days that drawings shall be submitted prior to fabrication should be based on consultation with construction division personnel in the district to determine a reasonable time.

c. Sample panels. Sample panels are required any time a Class A or a special architectural finish is required.

d. Forms. The areas on the project to receive each class of finish will be listed in the specification paragraph entitled "Materials" of CW-03101. This information must be taken from structural and architectural drawings.

e. Form removal. Forms will not be removed until a specified length of time has elapsed and a percentage of the concrete strength has been reached. The percentage figure to be inserted must be obtained from the structural designer.

5-6. Guide Specification "Expansion, Contraction, and Construction Joints in Concrete," CW-03150

a. General. This guide specification should be included in any project specification that includes joints in the concrete.

b. Cost of testing. Preparation of a project specification based on this guide specification requires that a division laboratory be contacted and costs obtained for testing field-molded sealants and nonmetallic waterstop. These costs are inserted in specification CW-03150.

5-7. Guide Specification "Precast-Prestressed Concrete," CW-03425

a. General. This Guide Specification CW-03425, "Precast-Prestressed Concrete," is for use on important structures which use precast-prestressed members; therefore, it is not intended to be edited except to select available options. Guidance for the section of the options is provided in the following paragraphs.

b. Air content. The decision of whether or not to require entrained air in precast members must be made based on a determination of the exposure conditions to which the members will be subjected both in service and in transit and storage. Generally, air entrainment should be required in any precast concrete placed in exposed locations where freezing of concrete saturated with water is likely to occur. When this decision is made, the optional paragraphs in the guide specification will be edited accordingly.

c. Tolerances. The optional tolerance paragraphs will be edited depending on the type of members being procured by including or excluding those paragraphs which apply to that type of member.

d. Cement. Guidance for selecting the various optional requirements is provided in paragraph 2-2 of this manual.

e. Aggregates. The option is provided if using aggregates meeting the requirements of ASTM C 33 (CRD-C 133) or if economically beneficial and technically acceptable, the specifications of a state or local agency may be used. This would be the case if, for example, the most likely source of precast members was heavily involved in producing units for a large highway department project and had produced large quantities of aggregate for that purpose. If the material was shown by case history or by testing to be adequate for the need, advantage should be taken of the availability and the resultant savings rather than forcing production of an aggregate meeting a different specification but offering no real advantage in concrete quality.

f. Finishing. Optional requirements are provided for the type of finish depending on architectural or service needs.

5-8. Guide Specification "Preplaced-Aggregate Concrete," CW-03362

Preplaced-aggregate concrete is produced by placing a gap-graded coarse aggregate in a form and later injecting a sand-cement-fly ash grout to fill the voids. Its main advantage is

its low volume change because of the high coarse aggregate content and the point-to-point contact of the coarse aggregate particles. See paragraph 11-2 of this manual for more information.